Trip Report for WEFTA Visit to VHP Projects in Bench Maji Zone, Ethiopia

April 2019

INTRODUCTION

At the request of Village Health Partnership (VHP), Scott McKitrick, P.G. (senior hydrogeologist) and Crispin Kinney, P.E. (senior engineer) travelled to the Bench Maji Zone of Ethiopia to review VHP-supported health clinics and hospitals existing and potential future water supply and sanitation projects. Accompanying them were representatives of VHP and teaming partner Afro Ethiopia Integrated Development (AEID). This trip occurred from April 19-28, 2019.

The WEFTA team arrived in the capital city of Addis Ababa on April 21, 2019 and traveled directly to Mizan Teferi, the administrative center of the Bench Maji Zone of the Southern Nations, Nationalities and Peoples Region of southwest Ethiopia. The Bench Maji Zone is bordered on the south by the Ilemi Triangle, on the west by South Sudan, on the northwest by the Gambela Region, on the north by Sheka, on the northeast by Keffa, and on the east by Debub Omo. The Omo River defines much of its eastern border. Figure 1 shows the location of Mizan Teferi in the southwestern highlands of Ethiopia.

WEFTA staff worked with VHP Board of Directors members Margaret “Migs” Muldrow, MD and Laury Bowman, JD, volunteers Patty Kelly, RN, Mackenzie Maloney, Zachary Towne and researchers Margo Harrison, MD of University of Colorado School of Medicine and Peter Van Arsdale, Ph.D. of the University of Denver Josef Korbel School of International Studies, as well as Shimeta Ezezew, Executive Director of AEID.

Lodging in Mizan Teferi was at the Salayish Hotel. Rooms were comfortable, water was generally available, and meals were good.

WEFTA's work focused on water supplies for health clinics and hospitals supported by VHP. Water system construction has been provided by AEID for several health clinics, most had been completed but some were still in process.

Due to health issues (McKitrick tooth abscess), the WEFTA trip was cut short, with travel home on April 28 instead of the planned date of May 3, 2019. We were not able to meet with Dugasa Beyene of the West Wollega Bethyl Synod or Dembi Dollo to discuss new and ongoing projects funded by Waterlines. Additionally, we were not able to visit the Daughters of Charity International Project Services compound in Addis Ababa to evaluate their existing water system.

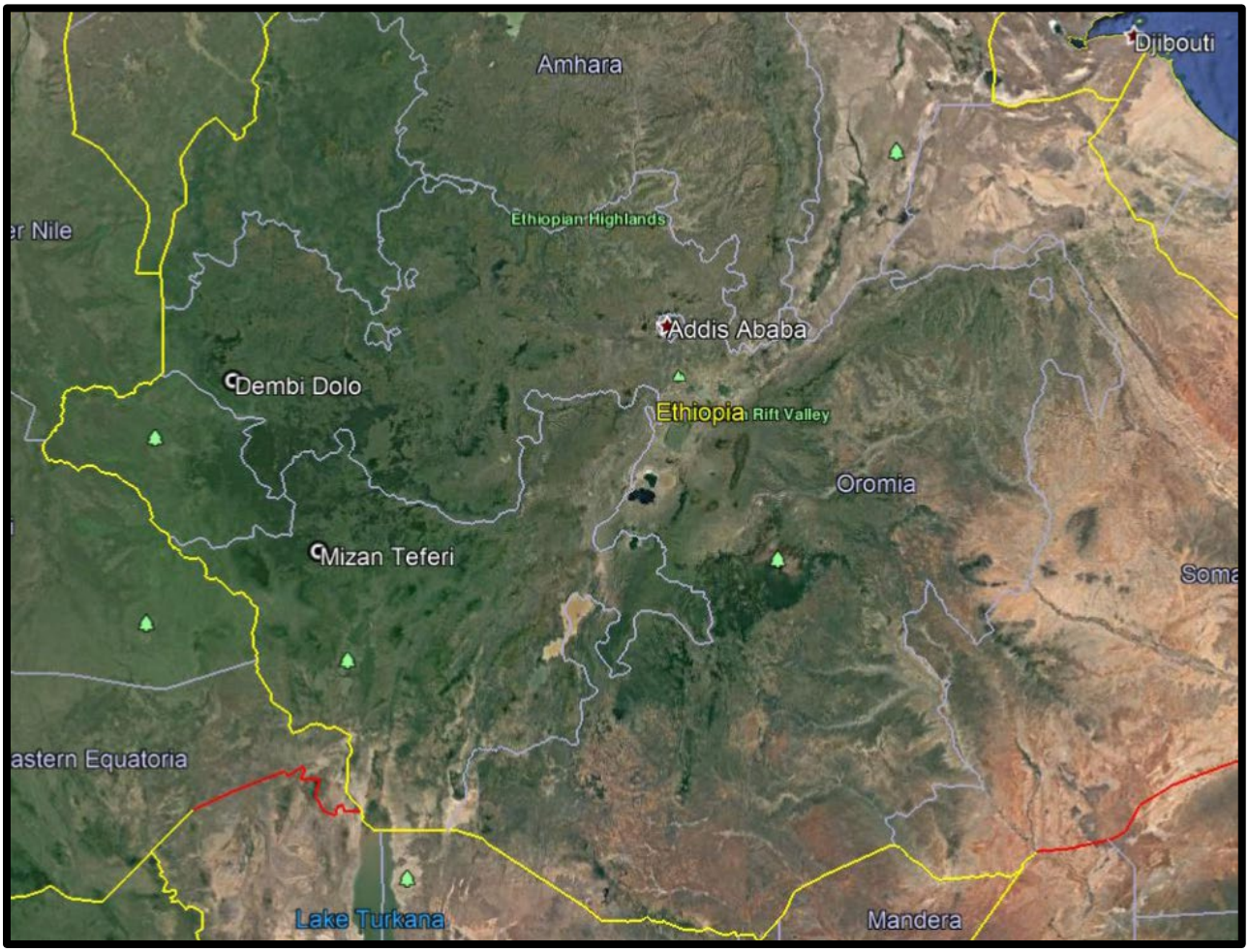

Fig. 1 - Map of Ethiopia showing location of Mizan Teferi

Location, Climate

The Bench Maji Zone has a population of approximately 650,000. Elevation of the zone varies from a high of 8,180 feet above mean sea level (AMSL) at Mount Guraferda to less than 1,400 feet AMSL on the Omo River on the southern Ethiopia border with the Ilemi Triangle, an area of disputed land between South Sudan and Kenya. Our work was conducted in the highlands, at elevations between

4,600 and 6,400 feet AMSL. The climate of the area is temperate. The rainy season generally lasts from May through October. Annual rainfall is approximately 60 inches.

Regional Geology and Hydrogeology

Geology of the field area is dominated by late Eocene to late Oligocene bimodal vulcanism, primarily Upper Jimma rhyolite and trachyte flows and tuff, and Lower Jimma flood basalt. Springs are generally related to surface infiltration of rainwater and located along shallow fractures in bedrock, thus rock type has little importance in spring location or flow. Shallow groundwater availability is likely related to rainfall infiltration and the degree of weathering or fracturing of shallow lithologic units.

Bench Maji Zone

Figure 2 shows the location of health clinics and hospitals visited, as well as Mizan Teferi.

Fig. 2 - Map of Bench Maji showing clinics and hospitals visited

Bench Maji Zonal Water Department Meeting

On Monday, April 22, 2019, the WEFTA/AEID team visited the Bench Maji Zonal water department and met with Kidame Nigusse Gurum, Assistant Head of the Zonal Water Department. We discussed the general operation of the zonal water department, and specifically the water situation

at Bachuma Hospital. We asked about the possibility of having the water department provide a crane to allow us to pull the pump from the well located at the former Chinese work camp proximal to the Bachuma Hospital but learned that this would not be possible.

Shay Bench Health Clinic

With the VHP team, we visited the Shay Bench clinic in the afternoon of April 22, 2019. Water supply for the clinic will be from the town water system. A 10,000-liter tank was present at the clinic, and the foundation for the tank had been constructed (see Fig. 3). Water will likely be available from the town system two to three times per week. A hand-dug well equipped with an Afridev Pump is present and functional at the clinic and will be used as a back-up supply. The Afridev Pump is a conventional lever action handpump. It is designed for heavy-duty use, serving communities of up to 300 persons. The maximum recommended lift is 45 m. The Afridev Pump is a public domain pump defined by Rural Water Supply Network (RWSN) specifications. The Afridev Pump is fully corrosion resistant, easy to install and has excellent potential for community-based maintenance; the pumps are common in Ethiopia. A new clothes-washing basin had also been recently constructed in association with the new maternity waiting area and latrines.

A placenta pit and medical waste incinerator had been recently constructed and looked to be in good condition. An unfenced pit near the incinerator was in use for trash disposal. It is recommended that the fence be extended to surround this pit.

Numerous hand-washing stations were present and functional. A diesel-powered electrical generator was present at the facility, but was not functional.

Fig. 3 – Shay Bench tank foundation and hand-dug well (at right)

Chebera Health Clinic

The Chebera health clinic was visited in the morning of April 23, 2019. Water supply for the clinic is currently provided by a single hand-dug well equipped with a hand-cranked rope pump. The well is reported to be 8 meters deep. The well provides water for most of the year, but at times dries up at the end of the dry season. Two additional wells have been dug at the facility, both encountered hard bedrock at approximately 6 meters and could not be advanced to groundwater. A 10,000-liter tank has been installed at the site, but is not plumbed to a water supply.

Fig. 4 – Chebera clinic hand-dug well and rope pump

WEFTA recommends the evaluation of a rain catchment system to provide water to the clinic. A preliminary evaluation (Appendix A) of the area of rooftop available and the likely rainfall of the area indicates a rain catchment system made up of rooftop gutters plumbed to a storage tank would be a viable water supply. We recommend the construction of a ferro-cement tank for water storage, as the existing fiberglass tank may cause stored water to be unacceptable to users due to warm water temperature.

Bachuma Hospital

Bachuma Hospital was visited by the WEFTA/VHP/AEID team in the afternoon of April 23, 2019. The hospital is a large, regional facility, of which only the maternity portion of the facility has been put into use. The facility was constructed in 2011-2012. The remaining facility is not in use because of the lack of water supply. The facility has adequate water storage, with two 25,000-liter tanks at ground level and one 5,000-liter elevated tank, equipped with an electric transfer pump to move water from the ground storage tanks to the elevated tanks for gravity distribution to the hospital. The facility also has a series of septic tanks for graywater disposal (but reportedly not fecal matter) on the north margin of the hospital property.

Fig. 5 – Bachuma Hospital water storage tanks

The hospital is connected to the Bachuma town water system, which does not provide adequate water for the facility. This system is discussed further below. The distribution piping from the town water system to the hospital is leaking (approximately two liters/minute) where it is present in the road near the hospital. Though the leak is ongoing, repairing the leak would not provide adequate

water to the hospital as the flow available from the town system is not sufficient for the needs of the hospital.

The WEFTA/AEID team returned to the Bachuma Hospital on April 24 to evaluate a nearby well. A camp was constructed sometime prior to 2011 approximately half a mile south of Bachuma Hospital by the Chinese government to house workers constructing infrastructure. The camp was equipped with a supply well, which is still present at the camp, but has not operated since approximately 2013. It was reported to be 102 meters in depth, with the pump set at 96 meters. During our investigation, the wellhead was elevated using two steel pipes and approximately ten strong men to lift the pump and drop pipe. Once lifted, the wellhead was propped open with a concrete block, and lifted further using two hydraulic jacks, to the point that the pump wires were accessible. Depth to water was measured at approximately 40 feet using a steel tape and chalk, and an attempt was made to determine the total depth of the well. The steel tape was not able to be lowered beyond 150 feet, which may represent the total depth of the well, or an obstruction that the tape was not able to pass.

We completed evaluation of the pump resistivity to determine that the pump is likely three-phase. Based on this determination, we connected the pump to two separate generators available at the site to attempt to put it into operation, which was not successful. Based on further evaluation, it appears the pump is no longer functional.

Fig. 6 – Evaluating Chinese Camp well

Following the evaluation of the Chinese camp well, we reviewed the Bachuma town water system. This system includes one supply well, a 30,000-liter storage tank, and 12 distribution centers (tap stands) throughout Bachuma, of which nine were functional when we visited. Approximately 50 hand-dug wells are also present throughout Bachuma, most equipped with hand-cranked rope pumps. The Bachuma supply well, reported to be 160 meters deep, is pumped approximately eight hours per day. The pump is powered by a diesel generator which was reported to require 60 liters of diesel for 8 hours of operation. The generator was reported to be in need of a new voltage regulator and battery. The availability of funding for diesel fuel is the limiting factor in the amount of time the well is pumped, as funds are limited. The supply well is located next to electrical lines, and therefore could be connected to electrical power; this would decrease the cost for pumping and likely allow longer daily pumping of the well.

Options to provide water supply for the Bachuma Hospital include:

- Purchase and installation of an electrical transformer to connect the Bachuma town well to the power grid
    - Estimated cost is $20,000 based on information provided by AEID-Shimeta Ezezew
    - Assumes the existing well is capable of longer daily pumping
    - Assumes that additional water would be available to the Bachuma Hospital, which would require an agreement with the Woreda Water Department
- Install a new supply well on the Bachuma Hospital site
    - A preliminary location was discussed, in the garden area on the front (west) of the hospital
        - Located as far as possible from the graywater disposal area on the north margin of the hospital
    - A revised location was determined by AEID approximately 100 meters to the northwest of the facility in an open field
    - Cost estimate to drill new supply well and equip with submersible pump is $50,000, based on information provided by Shimeta Ezezew
    - Electrical transformer at the hospital appears to be adequate to power the well pump
        - A backup generator is present at the Hospital, though it is oversized to run just the well pump and providing adequate diesel fuel would be an economic hardship
    - Hospital personnel would likely have control of the well, ensuring adequate supply for the hospital
    - Excess well production could be used by the Bachuma town water system, if they were to install a distribution line from the Hospital to the Bachum storage tank
- Use the Chinese camp well
    - Would require purchase and installation of a new pump, transformer for electrical connection from the grid to the pump (or purchase of a new generator), construction of a water line from the well to the Bachuma Hospital (1,300 meters)

- Given the great distance from the Chinese camp to the Bachuma Hospital, it is likely that installation of a new supply well at the hospital would be more cost effective than using the Chinese camp well

Based on evaluation of the stated alternatives, WEFTA recommends installation of a new supply well on the Bachuma Hospital site. WEFTA has reviewed the AEID proposal to construct the well, and has worked with AEID to determine that the well will be provided power from the existing transformer on the Bachuma Hospital site.

Additionally, WEFTA recommends working with Bachuma Hospital staff to determine startup requirements for the hospital related to water, wastewater, and potentially electrical power, as well as operation and maintenance requirements for these systems. The Bachuma Hospital was constructed in 2011-2012 and has sat idle since then. It is likely that providing water to the facility will show leaking water distribution piping, valving and fixtures, and potentially leaking wastewater piping and associated septic tank issues.

The Bachuma Hospital area, existing wells and the proposed new well are shown in the figure below.

Fig. 7 – Bachuma Hospital, proposed new well and nearby wells

Suri Area Clinics

Preliminary visits to three clinics in the Suri area were conducted on April 26, 2019, including clinics at Coca, Tulageet, and Kibesh. The Coca clinic had an elevated water tank and water distribution system, but did not appear to be connected to a water source. Water is reportedly available from a hand pump in the village. The Tulageet clinic is provided water from a spring source, which is piped to a portion of the town, with two distribution points. The Kibesh clinic also had an elevated

tank and distribution line, which was functional and in use during our visit. It is reportedly connected to either a spring or well source. The Kibesh facility had a photovoltaic electrical system on-site to provide power for refrigeration. This part of the system was not functional.

Fig. 8 – Functioning elevated water storage tank and tapstand at Kibesh Clinic

CONCLUSIONS AND RECOMMENDATIONS

Based upon this site visit, WEFTA volunteers have the following conclusions and recommendations:

1. Construct a new water supply well at the Bachuma Hospital, equipped with an electric submersible pump, to be powered by the local electrical grid

2. Construct a rain catchment system at the Chebera Clinic. Based on a preliminary evaluation, the tank should have a capacity of approximately 30,000 liters, and be equipped with a gravity-flow tap stand

3. Complete review of water system at Shay Bench Clinic that was under construction during the visit

4. Continue to support VHP with evaluation and recommendations related to water and photovoltaic systems at health clinics in the future

5. Provide training to local staff on operation and maintenance issues for VHP-supported facilities, particularly Bachuma Hospital

Appendix A
Chebera Clinic Rain Catchment Evaluation

The Chebera Clinic building rooftop covers an area of 337 cubic meters, based on measurements from Google Earth, shown in the figure below.

Figure A1 - Chebera Clinic showing conceptual rain catchment layout

Annual rainfall data is not available for Chebera, but is available for two nearby communities, Mizan Teferi and Shishinda (https://en.climate-data.org). Mizan Teferi is located 47.6 kilometers to the northwest of Chebera, at an elevation of 1,408 meters. Shishinda is located 58.6 kilometers to the north of Chebera at an elevation of 1,997 meters. Rainfall is generally directly correlated to elevation, therefore the annual rainfall at Mizan Teferi would represent an expected lower limit of rainfall at Chebera, while the annual rainfall at Shishinda would represent expected rainfall at Chebera. Mizan Teferi receives an annual average of 1,546 mm of rainfall, while Shishinda receives an annual average of 1,876 mm of rainfall.

Assuming that 80% of the rooftop area of the Chebera Clinic is available for rain catchment, the amount of water that could be collected on a monthly basis is shown in the table below, assuming an efficiency of 80% (80% of rainfall would be collected by a catchment system):

Table 1 - Range of Expected Rain Catchment System Water Availability, Chebera Clinic

	Mizan					Shishinda				
	47.6 km NE of Chebera					58.6 km N of Chebera				
	el 1408 m					el 1997 m				
		full roof		half roof			full roof		half roof	
	rainfall mm	l/mo (80% eff.)	l/day (80% eff.)	l/mo (80% eff.)	l/day (80% eff.)	rainfall (mm)	l/mo (80% eff.)	l/day (80% eff.)	l/mo (80% eff.)	l/day (80% eff.)
January	29	6255	208	3127	104	46	9921	331	4961	165
February	52	11215	374	5608	187	73	15745	525	7872	262
March	92	19843	661	9921	331	140	30195	1007	15098	503
April	118	25450	848	12725	424	173	37313	1244	18656	622
May	214	46156	1539	23078	769	241	51979	1733	25989	866
June	183	39469	1316	19735	658	215	46371	1546	23186	773
July	227	48959	1632	24480	816	228	49175	1639	24588	820
August	234	50469	1682	25235	841	240	51763	1725	25882	863
September	198	42705	1423	21352	712	229	49391	1646	24695	823
October	98	21137	705	10568	352	142	30627	1021	15313	510
November	66	14235	474	7117	237	94	20274	676	10137	338
December	35	7549	252	3774	126	55	11862	395	5931	198
total	1546					1876				

rainfall data from Climate-Data.org

Assumptions

Rainfall minimum equivalent to Mizan (500 m lower than Chebera), maximum equal to Shishinda (similar elevation)

Chebera Clinic roof area equal to 337 square meters

80% of roof area contributes to storage

80% of rainfall contributes to storage

From this data, it appears that a rain catchment system at Chebera Clinic would be a viable option to provide adequate water for clinic use.

WEFTA recommends construction of a 30,000-liter masonry tank on the southwest corner of the Chebera Clinic, equipped with an opening on top large enough to allow a person to enter and clean the tank, and a drain pipe for flushing during cleaning. Existing rain gutters on the Chebera Clinic (shown below) should be re-graded in order to allow rainfall to flow into newly installed pipes or gutters directed into the tank. The system should be designed in order to allow the first flush of water during a rainstorm to be wasted, in order to minimize contamination of the water. The system should be equipped with a gravity-flow tap stand, located to the north (down-slope) of the tank.

Figure A2 - Chebera Clinic existing rain gutters